Raising the Bar on Advanced Signal Simulation

Thomas Dippon, Agilent Technologies

Development of sophisticated satellite communication, radar, Electronic Warfare (EW) and Signal Intelligence (SIGINT) systems requires advanced simulation and measurement techniques to evaluate performance under all operating modes and to ensure performance specifications are met and fully characterized. Unfortunately for today’s R&D engineers, conducting the necessary signal simulation is not as straightforward a task as it may sound. For many of these applications, modulation bandwidth requirements are constantly increasing to accommodate higher information throughput, longer range and better resolution. Today, bandwidths of up to 2 GHz are needed, but future developments will face even wider bandwidth requirements. Further complicating matters, in order to keep signals with complex modulation schemes out of the noise floor, excellent signal fidelity and dynamic range is needed and distortions must be kept to a minimum.

Typically, engineers rely on an instrument like the signal generator to provide the signals they require for simulation and subsequent analysis. While traditional signal generators do provide excellent signal fidelity, their internal baseband capability only offers modulation bandwidths of about 100 MHz. Existing external arbitrary waveform generators (AWGs) can be used to achieve wider modulation bandwidths, but that capability comes at the expense of signal performance. To effectively meet the bandwidth and signal fidelity requirements of next-generation developments, today’s engineers now require another, more advanced alternative.

Raising the Bar

Delivering the signal performance that today’s sophisticated signal simulation applications demand calls for a high precision AWG, one that leapfrogs existing technology and literally raises the bar in terms of the functionality it can enable. With this instrument, engineers can generate realistic scenarios for radar, satellite and many other application areas (e.g., low-observable systems to high-density communications).

The high-precision AWG must offer higher bandwidth (2 GHz or more) and should support a modular form factor like the AXIe standard (www.axiestandard.org). With AXIe, the AWG can realize faster signal downloads due to a faster backplane and a much smaller size (e.g., roughly half the size of other competing solutions). Additionally, it must feature higher waveform resolution, something that is critical to reducing or eliminating spurs in the instrument’s output signal. Spurs can be misinterpreted as analog output and corrupt the spectral content of the output signal. Such effects can be caused by a variety of reasons, including the different timing of data bits, differential logic delay or a signal that passes the AWG’s digital-to-analog converter (DAC) before it is settled.

Traditionally, engineers requiring higher resolution had to either limit themselves to lower bandwidth or build their own signal generation solution. In conventional signal generators or AWGs, bandwidth is limited by the DAC sample rate, while accuracy is limited by all analog components. As a result, their performance is dependent on the DAC.

An AWG with excellent spurious-free dynamic range (SFDR) is one way to ensure higher waveform resolution. SFDR is defined as the ratio of the fundamental signal to the strongest spurious signal in the output and is a good indicator of signal fidelity. Generally speaking, an SFDR of 70 dB indicates a very clean signal.

Figure 1. Agilent Technologies' M8190A AWG features the advanced signal performance needed to support today's sophisticated signal simulation applications. Among other features, this 1- or 2-channel AXIe module boasts 2 GSa of waveform memory per channel, 5 GHz of analog bandwidth per channel and three software selectable output paths (DAC, DC or AC).

The M8190A AWG is a prime example of a precision AWG that offers both excellent signal fidelity and high bandwidth (Figure 1). Industry-leading SFDR and very low harmonic distortion stem from the instrument's use of a proprietary DAC fabricated in an advanced Silicon-Germanium BiCMOS process (Figure 2). The DAC operates at 8 GSa/s with 14 bit resolution and at 12 GSa/s with 12 bit resolution.

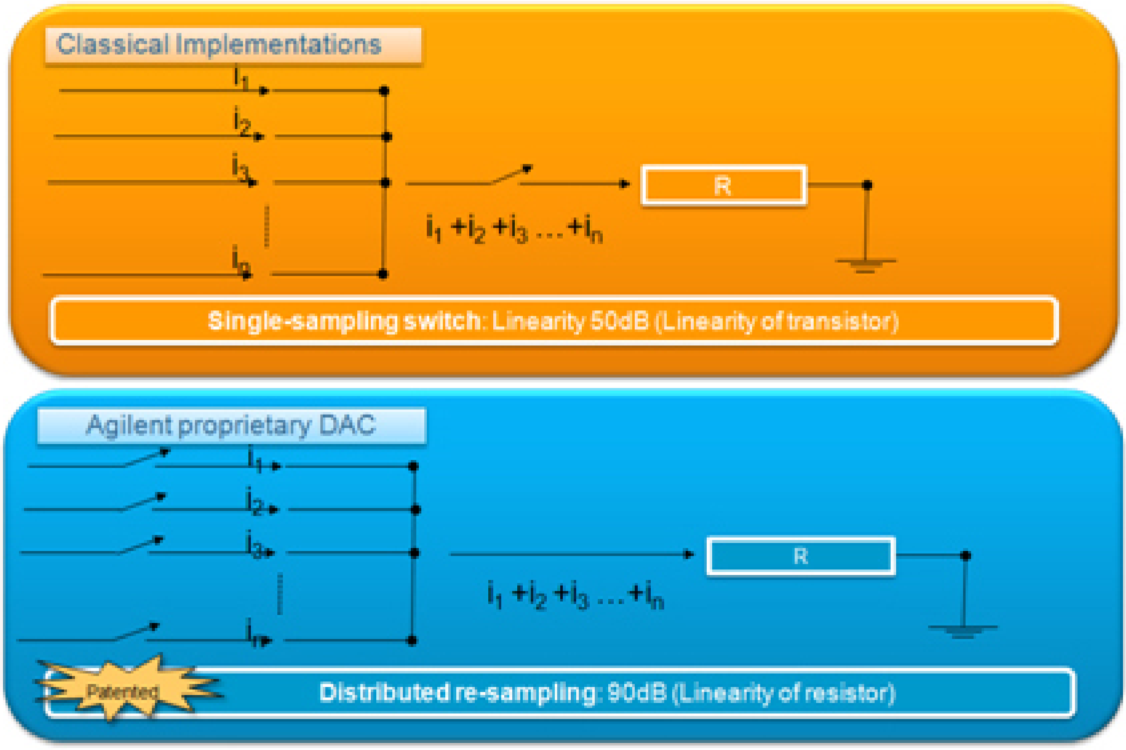

Figure 2. The M8190A's DAC addresses glitches by sampling after the transient is settled and then re-sampling with a special low-noise clock before it is delivered to the output. At 8 GSa/s, it typically delivers an industry-leading 75 dB SFDR across an output frequency range of 0 to 3 GHz.

The High-Precision AWG in Action

By combining excellent signal fidelity and high bandwidth in a single instrument, engineers can realize performance comparable to that of existing signal generators, while also gaining the ability to create signal scenarios that push their designs to the limit and bring new insight into analysis. The high-precision AWG can generate CW and two-tone signals, as well as more complex waveforms like multi-tone, wideband modulation, pulsed-radar, and multi-carrier signals. Generating multiple digitally modulated carrier signals at once can be very useful for testing wideband components (e.g., amplifiers) under realistic conditions. The high-precision AWG can also be used to perform fast frequency switching and to generate time-domain waveforms with any imaginable distortions calculated in the waveform.

As an example of a complex waveform, consider the multi-tone signal with 200 tones spanning a range of 3 GHz shown in Figure 3. A 100 MHz notch is left open to perform a noise-power-ratio measurement that it is frequently used to test amplifiers and other transmission circuits, in satellite communication and other wideband transmission systems. The signal was generated using a MATLAB utility available with the M8190A AWG. The utility also performs amplitude correction to compensate for the frequency response in terms of amplitude and phase of the signal path. With careful amplitude correction, a flatness of about ± 0.1 dB can be achieved.

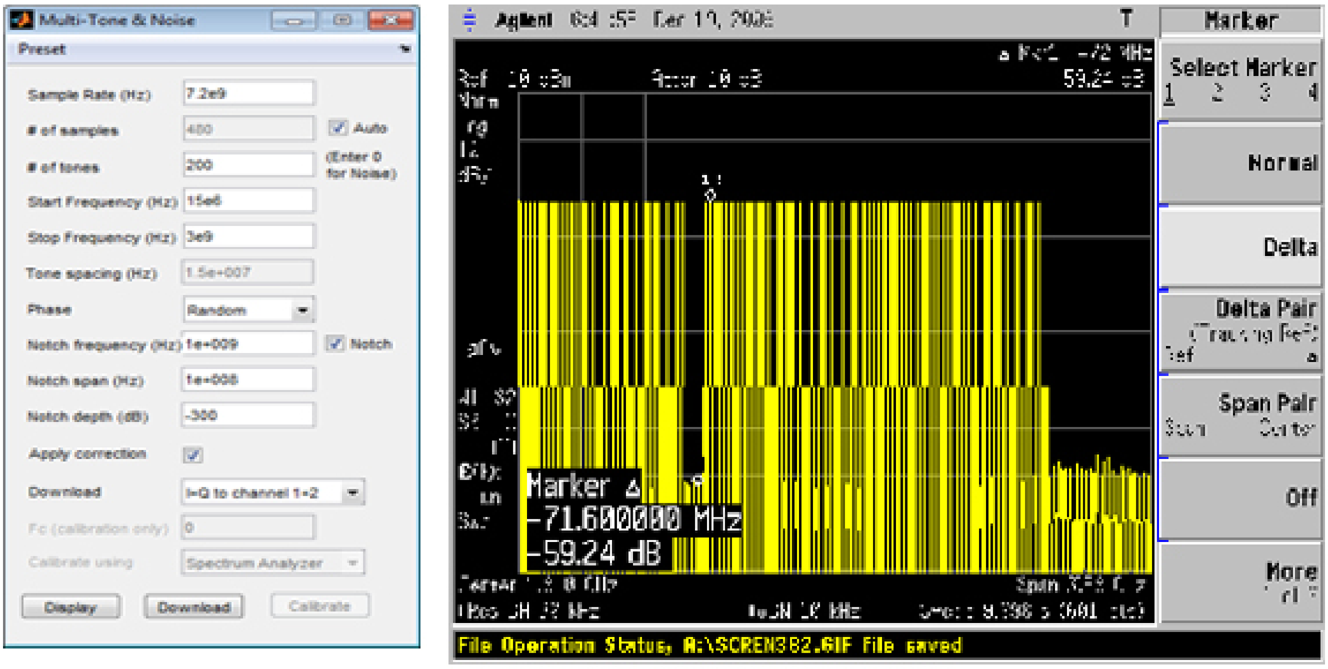

Figure 3. Shown here is a multi-tone signal with amplitude correction applied, generated using the M8190A AWG. Amplitude correction is included in the MATLAB utility on the bottom left of the screen. The resulting signal is very flat and the notch is almost 60 dB down.

Wideband signals like those in the communications space that are used in short-range, high throughput communication protocols (e.g., WiGig), can also be generated using a high-precision AWG. A prime example is a 16 QAM signal with 1000 MSymbols per second and a 4 Gbps data transfer rate. Because the instantaneous bandwidth of a spectrum analyzer is not sufficient to demodulate such wideband signals, a real-time oscilloscope must be used to capture the signal. In this case, the excellent signal performance of the high-precision AWG enables an EVM of less than 1% to be achieved, even at this high data rate.

Summary
Today’s sophisticated signal simulation applications demand a high-precision AWG that supports bandwidths of 2 GHz or more and features both excellent signal fidelity and low harmonic distortions. Support for a modular form factor is also crucial as it enables the AWG to realize faster downloads and a significantly smaller instrument size. With such functionality, engineers can quickly and easily create the realistic signal scenarios they need to push their next-generation developments to the limit.

For more information on high-precision AWGs, go to: www.agilent.com/find/AWG [1].

About the Author
Thomas Dippon works as an application expert and strategic product planner for pulse, function and arbitrary waveform generators. In his 20 years with Agilent/HP, he has held several positions in R&D, technical support and project management. Thomas is based in Boeblingen, Germany.

Source URL (retrieved on *09/17/2014 - 8:46am*):
http://www.ecnmag.com/articles/2011/06/raising-bar-advanced-signal-simulation

Links:
[1] http://www.agilent.com/find/AWG